Swift Report on GRB 090621A

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1 Introduction

At 04:22:43 UT, the Swift Burst Alert Telescope (BAT) triggered and located GRB 090621A (trigger=355303; Curran *et al.*. *GCN Circ.* 9540). There was also a second BAT trigger (trigger=355304) at 04:27:05, about 4 minutes after the initial trigger, from the same source, corresponding to the main emission episode (Figure 2). The peak count rate of the triggering event was ∼1000 counts/sec (15-350 keV), at ∼4 sec. This burst was also detected by the Fermi GBM (Rau *et al.*. *GCN Circ.* 9556).

Swift slewed immediately to the burst and the narow field instuments started observing 117 seconds after the BAT trigger. UVOT did not detect any credible afterglow candidate but the XRT produced an enhanced position at location:
RA(J2000) = 11.02150 deg (00h 44m 05.16s),
Dec(J2000) = 61.94110 deg (61d 56' 28.0")
with an uncertainty of 1.4 arcsec (radius, 90% confidence Page *et al.*. *GCN Circ.* 9567).

2 BAT Observation and Analysis

The BAT analysis of GRB 090621A has been performed by the Swift team, using the data set from T-239 to T+243 sec (Cummings *et al.*, *GCN Circ.* 9546). The BAT ground-calculated position is RA, Dec = 10.987, 61.938 deg, which is
RA(J2000) = 00h 43m 56.8s
Dec(J2000) = +61d 56' 17.6"
with an uncertainty of 1.7 arcmin, (radius, systematic and statistical, 90% containment). The partial coding was 77%.

The mask-weighted light curve shows two small precursor peaks starting at ∼T-30 sec, peaking at ∼T-20 and ∼T+10 sec, and returning to background at ∼T+100 sec (Figure 1). Then the main emission starts at ∼T+210 sec, peaks at ∼T+240 and ∼T+265 sec, and returns to background around T+350 sec (Figure 2).

Due to the long duration between the precursor and the main emssion, the BAT flight software retriggered partway into the main emission peak. As such the event-by-event data needed to perform the spectral fit for this burst was lost. The fit parameters below are for the time interval including the precursor, a long segment of background data, and only the first ∼10 sec of the main emission peak.

The time-averaged spectrum from T−31.0 to T+241.7 sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.78 ± 0.10. The fluence in the 15-150 keV band is $2.9 \pm 0.2 \times 10^{-06}$ erg/cm^2. The 1-sec peak photon flux measured from T+239.85 sec in the 15-150 keV band is 2.5 ± 0.2 ph/cm2/sec. All the quoted errors are at the 90% confidence level.

The results of the `batgrbproduct` analysis are available at:
`http://gcn.gsfc.nasa.gov/notices_s/355303/BA/`

3 XRT Observations and Analysis

The XRT began observing the field at 04:24:40.46 UT, 117.3 seconds after the BAT trigger and found an uncatalogued, variable X-ray source. Using 5877 s of XRT Photon Counting mode data and 11 UVOT images, the Swift team found an astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue) (Page *et al.GCN Circ.* 9567):
RA(J2000) = 11.02150 deg (00h 44m 05.16s),

Dec(J2000) = 61.94110 deg (61d 56' 28.0")
with an uncertainty of 1.4 arcsec (radius, 90% confidence Page *et al.*. *GCN Circ.* 9567).

The X-ray light-curve (Figure 3) shows a large increase in emission peaking at 264 s after the initial trigger, corresponding to the time of the second BAT trigger. If the BAT data are extrapolated into the 0.3-10 keV band, they align with the XRT data during this second trigger. The underlying decay can be parameterised as a broken power-law with $\alpha_1 = 0.74 \pm 0.06$, $\alpha_2 = 1.25^{+0.10}_{-0.08}$ and a break time of $T_{\rm break} = 17^{+5}_{-4}$ks.

As is common, there is clear spectral evolution during the flare. A spectrum extracted (Page *et al.GCN Circ.* 9543) from the first four orbits of PC mode data after the flare subsides (500 s after the trigger) can be modelled with a power-law of $\Gamma = 2.07^{+0.37}_{-0.35}$ and a total absorbing column of $(1.5 \pm 0.4) \times 10^{22}$ cm^{-2}; the Galactic column in this direction is 5.6×10^{21}cm^{-2} (Kalberla et al. 2005). Using this spectrum, the counts to observed (unabsorbed) flux conversion factor is $6.3 \times 10^{-11} (1.5 \times 10^{-10})$ erg cm^{-2} count^{-1}.

The results of the automatic analysis of the XRT data are available at:
`http://www.swift.ac.uk/xrt_products`.

4 UVOT Observation and Analysis

The UVOT began settled observations of the field of GRB 090621A 123 s after the BAT trigger. No optical afterglow consistent with the XRT position was detected in the UVOT exposures. The 3σ upper limits in the UVOT photometric system (Poole, *et al.*, 2008) for the first white finding chart (FC) exposure and subsequent co-added exposures, using a 4" aperture, are given in Table 1. Note that the white finding chart coincides with the bright XRT flare (264 s).

Filter	$T_{\rm start(s)}$	$T_{\rm stop(s)}$	Exp(s)	Mag
wh(FC)	123	272	147	>21.0
wh	563	7115	805	>21.5
v	613	6089	333	>19.4
b	538	6910	310	>20.5
u	282	6705	736	>20.5
uw1	662	6500	320	>19.8
um2	637	6295	333	>19.7
uw2	588	5884	333	>19.9

Table 1: 3σ limits using the UVOT photometric system (Poole, *et al.*, 2008) from UVOT observations. The values quoted above are not corrected for the expected Galactic extinction corresponding to a large but uncertain reddening of E(B-V) $\gtrsim$ 2 mag in the direction of the burst (Schlegel, Finkbeiner & Davis, 1998).

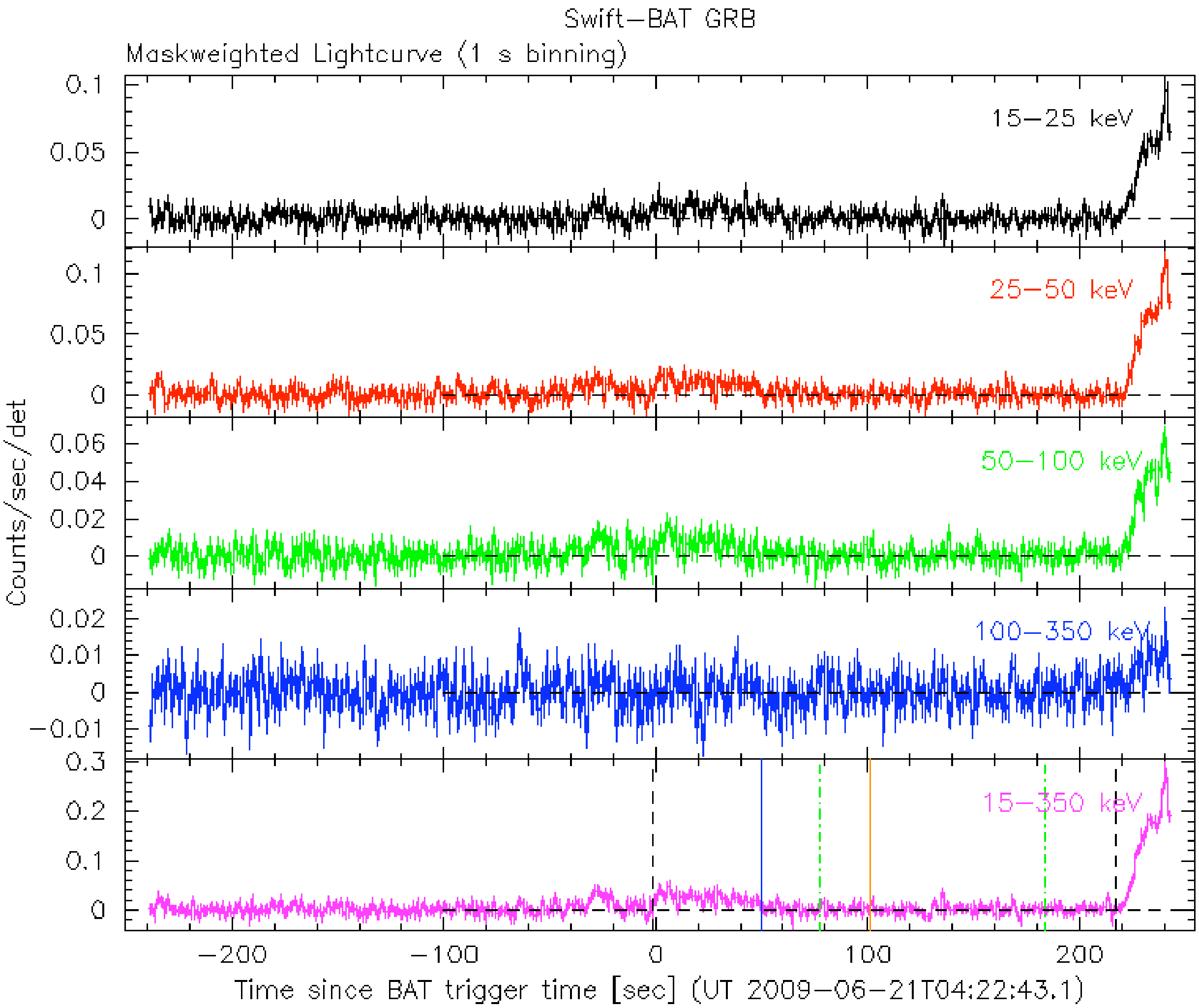

Figure 1: BAT Light curve of the triggering event. The mask-weighted light curve in the 4 individual plus total energy bands with units of counts/sec/illuminated-detector.

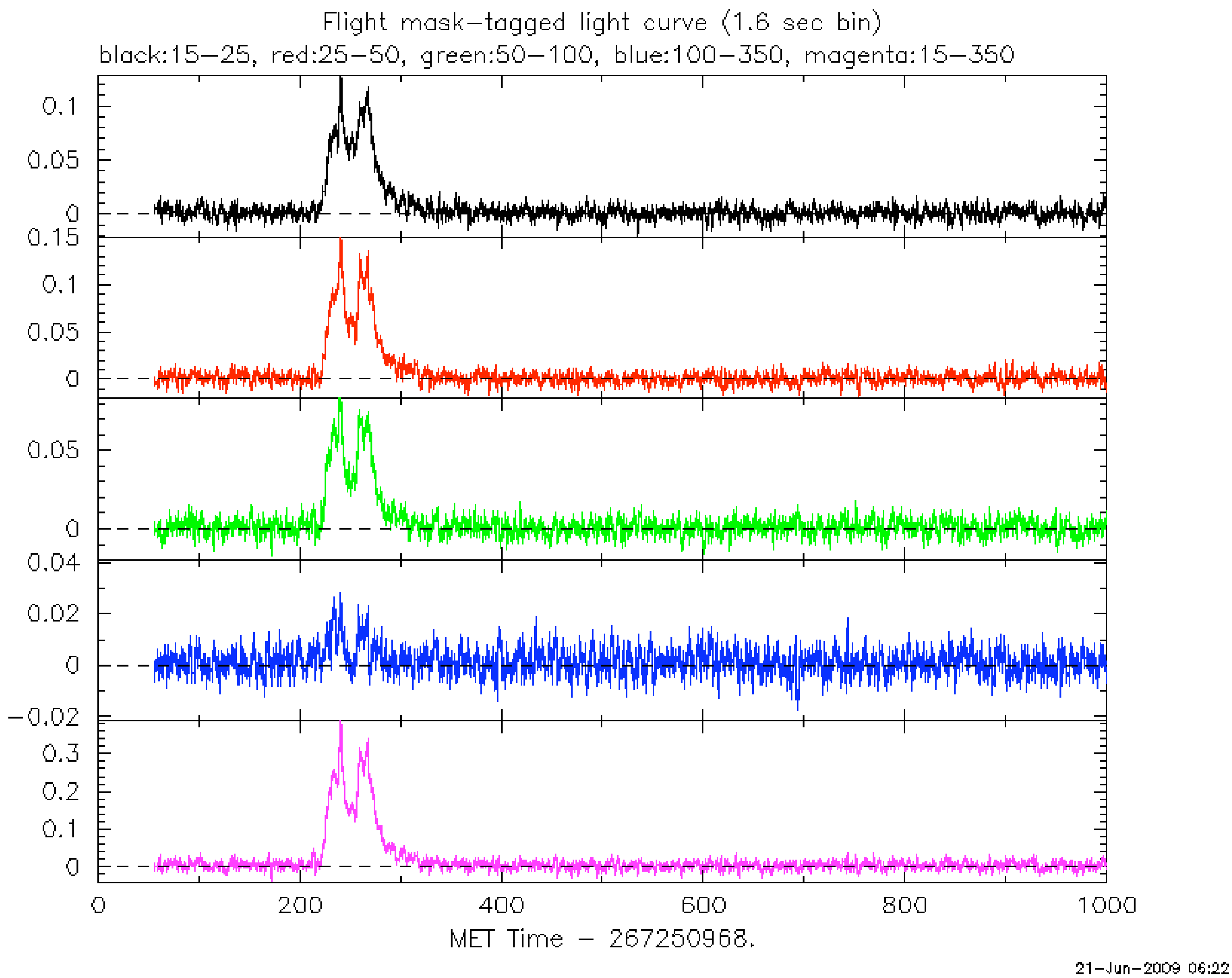

Figure 2: BAT Light curve of the main peak. The mask-weighted light curve in the 4 individual plus total energy bands with units of counts/sec/illuminated-detector.

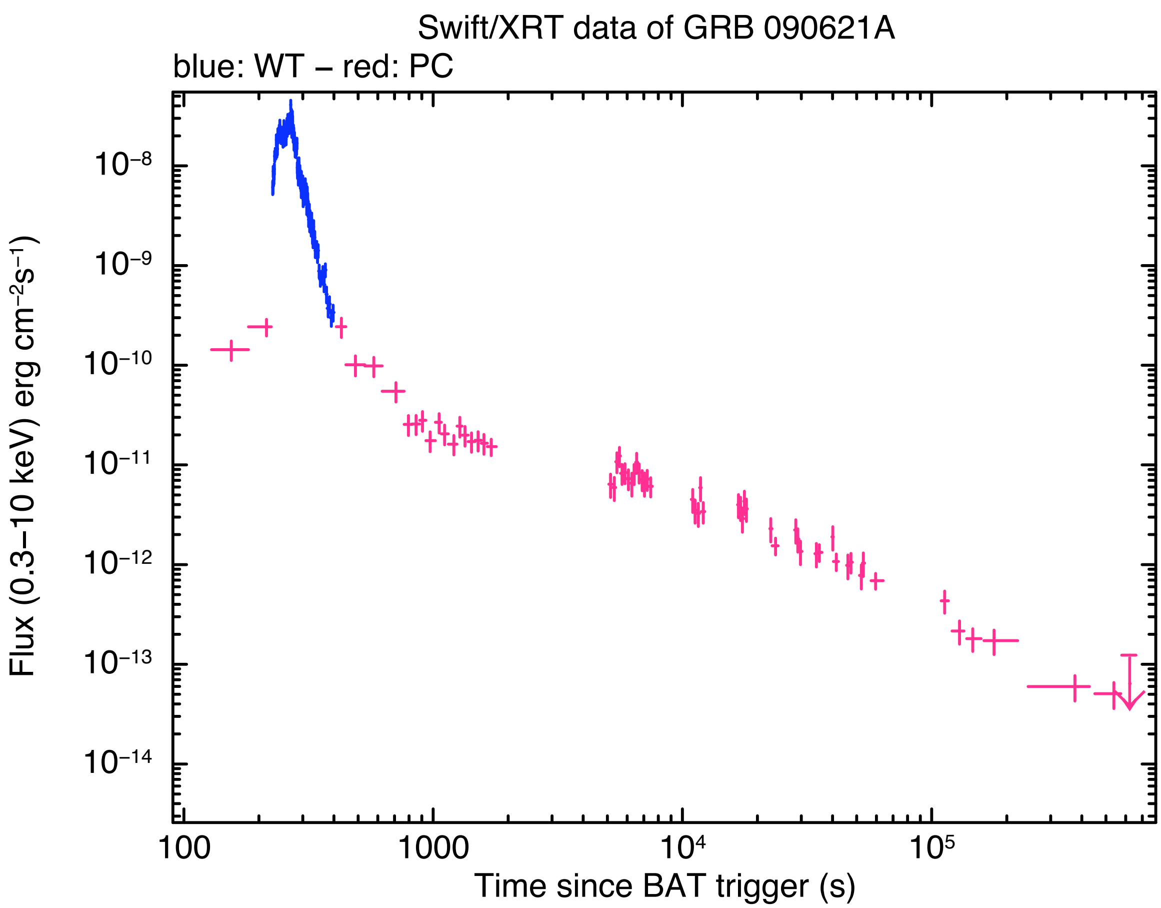

Figure 3: XRT light curve in the 0.3-10 keV band. The counts-to-unabsorbed flux conversion factor is 1 count = 1.5×10^{-10} erg cm^{-2} count^{-1}.